Sculptured Abacus in Cloister, Tarragona Cathedral.

GEORGE EDMUND STREET'S SKETCHES AT HOME AND ABROAD.

By Walter Millard [A.].

THE sketch-books of the late George Edmund Street, R.A., presented to the Institute by Mr. Arthur Edmund Street [*F.*], to which allusion has already been made in the Journal,* are five in number, spreading over a period of some thirty years; one of a tour in Germany and Switzerland made in 1851, three of tours in Spain in the course of the years 1861-2, and another of a tour in our own country during 1880, the last year but one of Street's life. In the case of the earliest of these books the interest it might hold for us is eclipsed by that aroused in the case of the four others. The sketches in this book, being made in pencil on ordinary hot-pressed paper, are slightly woolly in touch compared with those in the next-mentioned books done on a harder and finer surface. This may seem a point of small consequence; yet, to a draughtsman of Street's temperament, it was a point that did matter. In the smoother "metallic" paper of the three Spanish books it is evident that he had found a material responsive to the touch of his lead pencil-point, however lightly or forcibly it might be impressed, however swiftly or deliberately. The subjects with which this earliest book is filled range through a little over a week's travelling, from Nuremberg to Freiburg. Beginning at Nuremberg, on 4th September, he was sketching at Constance by the 10th, after having taken Ratisbon and Ulm on the way. At each of these two latter places he notes down in words the general plan and disposition of the cathedral building but the actual sketching done proves to be rather of the go-as-you-please order, by practice rendered so familiar to many of us; that is, the delineation of bits of buildings, parts, features and furnishings of various buildings met with, notably stall-work and stained glass in this particular case. The pursuit of a more definite and systematic line of architectural study is evident in the sketch-books that follow.

The three volumes containing sketches and notes made in Spain have a unique value for students of architecture, since, so far as they cover the ground, they comprise the very origins and foundation of their author's highly important work, *Gothic Architecture in Spain*, published in 1865. From this book Fergusson borrowed freely for his Spanish chapter, reproducing from it eight plans of churches and some dozen views. In making full acknowledgment of his own indebtedness to "Mr. Street's beautiful work," he adds, "His work is a model of its class, and has quite revolutionised our knowledge of the subject." Here, in these sketch-books, we find, in the freshness of their original pencilling, the actual plans and views with which we have been made familiar by woodcuts.

Sketch-Book, Vol. I., 1861, opens with sketches of detail from Notre Dame, Paris, dated 5th September, followed by others made next day at Bordeaux, of city gateways and cathedral tower. At Bayonne, on the 7th, Street took a sketch-plan of the cathedral and drew cloister fenestration, with cusped tracery, which must have struck him as a parallel to like work at Westminster and Salisbury.

* 25 Nov. 1916.

By the 9th of September he was across the Spanish frontier and at work in Burgos, making a measured plan of the cathedral. In the cloisters there he found another example of traceried work to compare with that at Bayonne. A plan and sketches follow of the church of St. Esteban, also of the church of St. Gil, where the wrought-iron pulpit comes in for a sketch. On the 10th he writes : " A day and a half at Burgos have impressed me most pleasantly in every way. The cathedral is equal to my expectations." He was at work in the conventual church and cloister of Las Huelgas on the 11th, and next day at Palencia, where the cathedral and the church of St. Miguel afforded subjects. By the 13th he had reached Valladolid, and here, as at Burgos and elsewhere, started work at one example after another by taking a plan of the building. " Without ground plans," he observes in his published volume, " it is impossible to understand any descriptions of buildings." Thus, with accompanying sketches, the churches of St. Benito and Sta. Maria Antigua are recorded.

Street had reached Madrid by the 14th, when he remarks of the Museo, " It is in most respects the best gallery I have ever seen. We went twice, and I should have liked to stay longer at Madrid and go again and again." From a picture there by J. Van Eyck he extracted some interesting detail. Then comes a note, " I went with 11,999 others to a bull-fight—saw six bulls killed." After that, on the 17th, he got away to Toledo, where evidently he was once again in his element ; for next morning he writes, " In the cathedral soon after 6 a.m. and had two hours' work before going to breakfast." The series of sculptured-panels on the screens behind the choir-stalls claimed his attention, and he seems to have sketched all the panels on the south side. Two days later he records, " To cathedral, 7 a.m., but found it too dark to sketch subjects on north side of choir. Must not complain, every window full of rich stained glass." His drawing of these sculptures, in its simple directness and firm handling, is a model of what such work should be. At Toledo, Street came in contact with Moresque building-forms, several instances of which figure in his sketch-book. And these are not all of them purely secular subjects ; for, strange as it may sound, the architectural expression of the Moslem invaders long survived their expulsion and for more than another century continued to assert itself actually in the very church structures of their conquerors. Evidence of this lies before us in sketches here, showing multifoiled arch-forms and other marked characteristics, from more than one church, and even from the cathedral itself. On the 20th a note is made, " Travelled all night to Valencia."

Sketch-Book, Vol. II., leads off with a plan of the cathedral at Valencia. Two days later Barcelona is reached and again a plan is taken of the cathedral, and a section also, together with interior and exterior views, besides many details of piers and arches, all mutually explanatory of the structure as an organic unit. " I was charmed," he says, " to find so noble and complete a church here." A plan, too, was drawn of the fine church of Sta. Maria del Mar, as well as interior and exterior views. Leaving Barcelona on the 25th, the traveller gets to Zaragoza on the following day, and on the 27th he writes, " Out this morning at 6.30 to make the most of my time." At Lerida and Manresa fine subjects were tackled, only too hurriedly ; and then came Gerona. Here Street writes, " Our first visit was to the cathedral. The west front promised nothing as we went up the steps. What our surprise was when we opened the door and found ourselves inside the nave I can hardly say. I was so struck by the enormous width that I stepped it and found it to be 75 feet in the clear ! This is the greatest span I have yet seen, yet the whole stands perfectly and with scarcely a settlement. The most remarkable thing is that this wonderful and spacious nave opens into a choir and aisles with chapels round it, and together just occupying the east end of the nave, into which they open with three arches. The effect is grand in the extreme." Of this work a measured plan is duly made and an interior view, which figures in Fergusson's chapter.

By the end of the month the frontier had been re-crossed, and Perpignan reached. There follows an important series of sketches from Elne, Narbonne, Carcassonne, Villefranche, Toulouse, Montmajour and Arles ; and then, under the date 6th October, comes a sketch made at the Hotel Cluny, Paris, just one day over the month since our travelling-student had begun work, in his Sketch-Book, Vol. I., at

TARRAGONA CATHEDRAL: VIEW ACROSS TRANSEPTS.

Notre Dame. His Vol. II. closes with sculpture from the west portals at Amiens, drawn as he had drawn that at Toledo, with clean incisiveness and complete mastery. A note made of detail at St. Martin's Priory, Dover, marks his return home.

In the following year, 1862, Street was back in Spain as early in the season as May. Again he was attracted to Gerona, which he reached on the 25th; and after that came Barcelona once more, then Tarragona, Manresa, Lerida, Huesca, and Zaragoza. By June 2nd he was at Tudela on his way back, *via* Olite and Pamplona, to the frontier. This second tour was only about half the length of the first. A third and last one undertaken for the sake of his Spanish book, is not represented in this collection. It embraced the north-west district as far as Santiago di Compostella.

From June, 1862, to August, 1880, is a long interval; but when we come to the next sketch-book that we possess, of the latter date, we can detect no sign that the hand which had done the sketches in Spain had lost aught of its cunning. It may only be noted that a return is made to Whatman's hot-pressed paper. This sketch-book, of 1880, is filled with subjects in this country, extending from Bradford-on-Avon through Somerset and Devon, during August; and then, in September, comes a northern series proceeding through Cumberland, Yorkshire and Cheshire.

Each of these sketching-trips appears to have occupied about the inside of a week. The sketches made in the first week, at Bradford, Bruton, Brympton, Montacute, Barrington Court, Forde Abbey, and Ottery St. Mary, amongst others, finishing up with subjects of his own creation, viz., the church he had built at Minehead and his nave at Bristol, evince all the artist's old power behind the pencil. The sketches made the following month, in the north, start with the west front at Lanercost, against which is the note, "How much subdivision in small width!" Bolton Castle and Mount Grace Priory, in Yorkshire, also the city of York itself, afford further good subjects.

About Street's architectural tours we may certainly say that there was something of the zest of adventure combined with high seriousness of purpose on his part to accomplish the utmost of which he was capable, under given circumstances, in the reading of the works of the past that lay in his way, like documents, so to speak, awaiting decipherment and interpretation. Clearly, he was not out just to fill sketch-books, though he filled many: but, with the true instinct of a student, he drew things that he cared about because he cared about them and wanted to know all he could get to know about them, not for the sake of the pictures they might present on paper. His sketches were made as studies for his own purpose and not for show, still less for reproduction in facsimile. He had no time to spare for overmuch playing with his pencil, and he never fumbled with it. Fastening on the salient points of his subject, and ignoring non-essentials, he would mark down with prompt decision and with precision just what he wished to record, and no more. He seized on what he wanted, on what to him signified, and drew it—and it alone. Whatever parts of any particular subject might be left unrepresented in his sketch, those things he did indicate would still come in their right place on the paper in relation to the whole, however slightly they might be suggested. Whilst he was at it his head as well as his hand were at work, and the discriminating process of selection and elimination went on continuously. As for the workmanship of his sketching, we find that, no matter how intricate in plan may be his subject, how sharp the perspective, or how difficult the view, nearly invariably arches and vaulting, caps, bases, and plinths, tracery also and high buttress-tops, all come out faultlessly in—drawing; and this in cases where he must almost certainly have sketched standing,* as an architect would, if necessary. Free and fearless might be apt enough terms to apply to his handiwork, perhaps it would be even still better described as incisive and masterly.

As a young man Street fell in with the rising-stream of outdoor sketching and study of remains of the past which he must have found running at good flow in Scott's office, when he entered there, in 1844. For, this office, where he spent some five years as an assistant, proved a veritable school of architectural sketchers; as his own office, in its way, was destined to become in turn—an assertion which

* I have it on the best authority that, as regards standing to sketch, he did so habitually.

sketch-books of Norman Shaw's, recently presented to the Institute by Mrs. Norman Shaw, go to substantiate. The early imbibed impulse to study and to sketch what we like to call old-work never weakened with Street. We read of its being implanted in him as a boy by the example and encouragement of his elder brother. It remained his recreation, and much more than mere recreation, to the last. All along it served him as an aid to his life's work, not just because this old-work was old, but because, as being the work of past-masters in building, it held a message for him as an architect. To the very end of his life he loved to scour the country, this country and other countries too, with an eye on the surviving examples of old building-work, mediæval in particular, and especially on its definite architectural forms, features and details; work that spoke to him and to which he responded.

As no two students of architecture following the same route could be expected to view with equal eye each identical piece of building-work they encounter, or to draw from it precisely the same lesson, so also can no exact agreement be looked for as to methods of procedure in making their studies of the work. Thus, even within the comparatively limited field of mediæval art, there soon proved to be room for at least two schools of thought regarding the lines on which its investigation should be pursued by our architectural students. The sketchers and the measurers, as these two schools respectively came to be labelled—with inexactness common to all such systems of labelling—may be said to have each produced its champion, or at any rate typical representative, in the person of Street, as a sketcher of old-work, and Burges, as a maker of measured drawings from it. Not, of course, that either of these really confined himself to one method of expression in his architectural studies, as his label would require had it been an exact one; but, still, there undoubtedly was a generally recognised divergence of view; and this difference we may regard as virtually being brought to an issue by Burges. Street, Nesfield and Norman Shaw, not to name others, had already published volumes, in which pictorial views of architectural subjects very largely predominated over illustrations to-scale, when Burges, in 1870, brought out his Folio Vol.* of measured drawings, and in the Preface to it sounded this warning note to would-be students of architecture :—

"When a pupil I was taught that the proper way to study was to draw rough perspectives in a little sketch-book, accompanying these rough perspectives with small drawings of the details and a few measurements. The great object was to fill the sketch-book, and then on return to town the perspectives were to be drawn out more carefully. . . . Each of us tried how many more sketches he could make in a day than his companion. On return home these sketches were cleaned up, had their margins cut, and were pasted into nicely-bound scrap-books and reserved, as a very cynical friend used to observe, 'for the inspection of parents, friends and idiots.' . . . Luckily for me, my cynical friend did not cease to ask, why I drew this sketch? Of what practical good was that detail? Why had I not drawn the full-size curves of some particular moulding? I forthwith made up my mind to turn over a new leaf and to take an opportunity of measuring and, as it were, dissecting the best French architecture of the thirteenth century I could find. . . . I set myself to write a sort of grammar of thirteenth-century architecture and to illustrate it with carefully measured details. . . . On my return to England I had a very different collection of drawings from that which resulted from my former travels. The inaccurate and often careless sketches had given place to documents; but it must be confessed that these latter had but little attraction for the outer world . . . But to myself they were very valuable, for they had taught me the why and wherefore, which is the base of all architectural knowledge."

It may be observed that the years when Burges was a pupil to Blore, who held the Surveyorship to Westminster Abbey, coincided with some of those spent by Street in Scott's office, so that teaching as to the proper way to study would probably, in these two leading offices, be much the same for both young men. However this might be, Burges's warning note some twenty years later did not come at all too soon, in view of certain developments in the meantime. But it fell to a great extent on deaf ears. There was danger, indeed, lest the accomplishment of architectural sketch-making, that most alluring of short-cuts to success in an architectural career, should be deemed sufficient in itself for the turning out of trained and accomplished architects. Again, in these latter days, has the danger signal been repeated; for have not we, too, heard the cry? "Burn your sketches; better still, make none!"

Yet, widely as our two leaders may have appeared to differ in their individual ways of pursuing their studies from architectural remains, they agreed to the extent of giving proof, as architects, of

* *Architectural Drawings: Measured Examples from France, England, and Italy, illustrating 13th Century Work*, by William Burges.

sound learning and true scholarship ; and possibly, at bottom, they were not so very far asunder after all in their beliefs. Each, as an outdoor student of architecture, would proudly claim to stand in the line of succession from Villars de Honnecourt, architect of the thirteenth century, whose vellum sketch-book has come down to us, a witness to continuity in the pursuit by architects of outdoor study direct from standing examples of building-work. They were both students of great faith, and each after his manner went about the getting of the knowledge and the inspiration that he sought—in a word, pursued the business of working-out his own salvation as an architect—with a singleness of aim and fixedness of intent that are beyond comparison with a great deal of our architectural sightseeing and posy-gathering since their day. This much for certain they can be said to have held in common—viz., a firm belief in the essential need for the architectural student really to learn first-hand from structure itself something of the work of his forerunners in the art of building-device. And this has become a very corner-stone of our faith in regard to the training of recruits to the architectural profession. However great, or however little, may be the weight allowed to the authority of old-masters in present-day schools of painting for instance, we, at any rate, in our schools of architecture can no more divest ourselves of our inheritance from the past than we could, if we would, divest ourselves of it in the case of language, of literature, or of law ; and the difference in value between first-hand and second-hand acquaintance with ascertainable fact hardly needs to be emphasised.

Looking over these Spanish sketch-books, and reading the notes interspersed with the drawing, one cannot fail to observe how, with an architect's insight, Street regards building after building, that he takes count of, as a structural unit to be investigated as such and not just treated as a quarry to be ransacked for specimens ; a unit to be viewed and comprehended as a whole, as it stands and as it has come into the shape it holds. It was for this that he filled his sketch-books, being a student who wanted to know and determined to see and to find out for himself. Having got down on paper a plan, and if possible a section, of a particular structure, to explain the general make and fashion of the thing, or perhaps its growth through long years, his further studies of parts and aspects of it then fell naturally into their proper place in the survey. Not that he stayed, of course, in every case to complete such a survey in his sketch-book ; but we may feel pretty sure that each building noted was surveyed as a whole mentally, judging from those examples best worth record that he could find opportunity to dissect and display on paper. In viewing thus the work of the past, true archæologist as he was in his regard for it, he could not have failed to be mindful all the time of the work which he felt lay before him to do. It would surely be in good hopes of gaining light by which to discern his way ahead that he looked back reverently upon the achievements of his forerunners in building.

As evidence that Street, for all his sketching propensities, by no means neglected the practical and structural side of building-study we need only turn to his Paper on *English Woodwork in the Thirteenth and Fourteenth Centuries*.* This Paper, he told me, with a gleam of humour in his blue-grey eyes, had by him as a student been submitted unsuccessfully for the Institute Essay Medal. The author bided his time. Some years passed, when one day he found himself invited by the Council to read a Paper before the Institute. To this invitation he responded with his best attempt, on a subject of his own choosing. At the close of the discussion on this, in acknowledging the vote of thanks and all the nice things just said about his effort, he gently disclosed the fact that he had now, a second time, submitted for the verdict of the Institute his original Paper, unaltered, on Mediæval Carpentry in England, which before had not succeeded so well in finding favour in the eyes of the authorities.† By that time he was a Vice-President. It was in this Paper that he gave expression, as an Englishman, to a sentiment which still to-day would meet with a responsive echo. After quoting Viollet-le-Duc to

* Reprinted in R.I.B.A. TRANSACTIONS, Vol. V., New Series.

† I am bound to say that no record of this little episode appears in the printed Transactions ; but my recollection is perfectly clear as to the substance of what Street himself told me.

the effect that, to see open-timber roofs you must go to England, he remarks, "Our insular pride is of no new birth, and was as strong and decided five hundred years ago as it is now."

His truly British tenacity of purpose and power of making long-sustained effort seem to have confirmed him in the habit, never relaxed apparently, of getting through in a given time the very maximum, whether of work or travel. He so liked to "get along." I remember how, in one of his lectures to us students at the Royal Academy, he made mention casually, as it might seem, yet with intent, I felt sure, of the fact that, one day shortly before, he had happened to be in the cathedral of Amiens and then, next morning, found himself in that of Exeter; proceeding, of course, to make the inevitable comparison between these two works. Another illustration occurs to me of his customary carefulness about the utilisation of time and opportunity. Having occasion to send me down to Coventry for the day, to obtain some measurements, he genially added to his instructions, "If I were in your place I should go down by the newspaper train and so get for myself, after finishing my work, all the spare time I could have in that old city." He seemed to know of, and doubtless did know, most good things in the shape of architecture in all parts of the country, and in this knowledge he took some pardonable pride; so, I could not help feeling mildly moved to smile whilst noting his frame of mind on my telling him, concerning a particular tour which he had most readily and kindly planned out for me, that I proposed to amplify this programme by starting work at Maldon, in Essex, where, according to Murray's Guide, I should find a thirteenth-century church steeple which was triangular on plan. "I never heard of it," he snapped out. "However, you may go and see. I daresay it's all a hum." I did go, and had the satisfaction of making measured drawings of that steeple.

One display of Street's sketching powers, not readily to be forgotten by those who witnessed it, was the illustration by his own hand, with chalk on the blackboard, of a lecture that he gave to the St. Paul's Ecclesiological Society, on English mediæval mouldings. From beginning to end the demonstration kept pace with the delivery of the address. Truly it was an effort that seemed to call for some kinder fate than to be wiped out with a duster.

He must have been on his very last Continental tour, perhaps his last sketching-trip of all,* when my friend, Leonard Stokes, and I, in the summer of 1881, arriving at Limburg-on-the-Lahn, found that we had just missed him there. It would have been a new experience for us could we have watched him at work—this time not at the drawing-board—facing some subject of his choice sketch-book in hand.

[NOTE.—The illustrations on pp. 97 and 99 were reproduced from one of the Sketch-books some time ago when it was intended to give several more. The idea, however, had to be abandoned owing to the great advance in the price of blocks.—ED.]

* His tour was planned as follows, but circumstances necessitated its curtailment by the omission of the four places last-named:

June 18.—Limburg-on-Lahn.
" 20.—Eisenach.
" 22.—Erfurt.
" 24.—Naumburg.
" 27.—Leipzic.
" 29.—Dresden.
July 2.—Berlin.
" 4.—Stralsund.
" 7.—Magdeburg.
" 9.—Halberstadt.
" 11.—Hildesheim.

GRAPHICAL CALCULATION OF BENDING MOMENT IN CONTINUOUS BEAMS.

By JOHN H. MARKHAM [*A.*].

THE method described in this article was first presented to English readers in its present simplified form in an Appendix to Mr. Wm. Dunn's *Lectures on Reinforced Concrete*, published by the Cambridge University Press, 1911, and again in the 3rd Edition of Messrs. Marsh and Dunn's *Manual of Reinforced Concrete*, no proof being given in either case. The demonstration which follows is based on the treatment of the subject in the American and German authors referred to by Mr. Dunn.

ENUNCIATION OF METHOD.

§ 1. In dealing with beams by this method it is necessary to consider the loading on each span separately, all other spans being assumed free from loading of any kind—not merely without live load, but as though no weight of any kind existed in them. Then the bending moment diagram of all the various loads which are to be assumed to be acting together in all spans in any given case is found by summing the ordinates of each of the diagrams found separately for each span, due regard being had to the sign (positive or negative) of the ordinates.

§ 2. In Fig. 1 a beam is shown subject to loading in the second span only. This beam happens to consist of five spans, but they are of irregular lengths and the description and reasoning are absolutely general.

Divide each span (Fig. 2) into three equal parts and through the points of division draw verticals TV_1, TV_2, etc. These are known as "third verticals." (In the end spans if, as is usual, the end of the beam is considered freely supported—not fixed—only the third verticals farther from the end need be drawn.)

§ 3. Take the horizontal distance of TV_2 from b (the support) and set it off from TV_1 giving the point v_3. Then the space between TV_1 and TV_2 is divided at b so that $v_1b=\frac{1}{3}l_1$ and $bv_2=\frac{1}{3}l_2$; while at v_3 it is divided inversely so that $v_1v_3=\frac{1}{3}l_2$ and $v_3v_2=\frac{1}{3}l_1$. Through v_3 draw a vertical LT_b. This is known as a "limited third vertical"—a curious name: "inverse third vertical" would seem more suitable. Similarly draw LT_c, LT_d, and LT_e.

§ 4. Beginning from point a (left-hand end) draw an inclined line in any direction to meet LT_b in g. From intersection of this line with TV_1 in h draw hj through support point b to meet TV_2 in j. Join gj intersecting the beam line in i_1. From i_1 draw line i_1k to any point k on LT_c, and from intersection l of this line with TV_3 draw lm through support point c to TV_4. Join km giving i_2 at intersection with beam line. Proceed in the same way to find i_3, and then i_4, p being the point on TV_3 through which op is drawn to give i_4. From f (right-hand end) draw fp produced to intersect LT_e in q. Join qn intersecting the beam line in i_5. From i_5 proceed towards the left as last described and find i_6, then i_7, and lastly i_8.

§ 5. In Fig. 3 the beam spans are set out and the "i" points found by the construction just described are marked.

The second span, bc, is to be considered as loaded as shown in Fig. 1, all other spans being entirely without load. In Fig. 1 the hatched area represents the bending moment diagram for the load system if bc were a one-span free-ended beam. Let A be the area of this moment diagram. (This quantity, A, will be in terms of the product of linear units and bending moment units—*i.e.*, ft. × ft. lbs., or in. × in. lbs.) Let b_g be the distance from support B, and c_g the distance from support C, of the centre of gravity of the hatched area as shown in Fig. 1. Then in Fig. 3 set off vertically downwards from b a length equal to $\frac{A \times b_g}{\frac{1}{6}l^2_2}$ and from c a length equal to $\frac{A \times c_g}{\frac{1}{6}l^2_2}$. (These quantities will be in moment units and must be set off to the same scale as that to which the bending moment is to be drawn—the same as that to which the diagram in Fig. 1 is already drawn.) Join the point so found below b to c and that below c to b intersecting on the vertical through the centroid of the free-end bending moment area. These are known as the "cross lines."

§ 6. From i_1 and i_7 drop verticals to meet the cross lines in r and s. Join rs and produce to meet the support verticals in t and u. Then bt and cu will be the negative moments at the supports B and C respectively. Join ta; and draw ui_6 produced to meet the support vertical d in w. Draw wi_5 produced to meet support e vertical in x. Join xf; and the hatched area then represents the complete bending moment diagram for loading on span bc only. In Fig. 4 this is shown on a straight line base, $a, b, c \ldots f$. This is obtained by setting up bt' equal to bt (Fig. 3) and cu' equal to cu. Join $t'u'$; and on this line as base draw the bending moment diagram t', w', x', y', u' in which each of the vertical ordinates, such as $w''w'$, $x''x'$ and $y''y'$, is equal to the ordinate in the same position in Fig. 1 (the free-end diagram). Then, to get the moments in other spans, join $t'a$ and draw $u'i_6$ produced to support vertical d, etc., as last described.

In practice the finished bending moment diagram (as Fig. 4) for one span loading need not be drawn. When the support moments bt, cu, dw and ex (as in Fig. 3) have been found, the support moments for the loading on each of the other spans (taken separately) would also be found. A summation of these support moments at each support would then be made giving points such as t'', u'', d'' and e'' as defining the support moments, bt'', cu'', etc., for the combination of loadings in each span. Then on the base lines at'', $t''u''$, $u''d''$, $d''e''$ and $e''f$ the bending moment diagrams for the load on each span would be drawn giving a

figure somewhat as shown by the broken line (Fig. 4). This would be the finished bending moment diagram for the assumed combination of loading arrangements in the different spans, the areas below the line *abc . . . f* being positive and those above negative. Several of these diagrams would have to be drawn so as to take account of dead load only in certain spans being combined with full load in others, and so forth, to show the worst possible combinations at all points.

PROOF.

§ 7. The following two assumptions are made in this method.

(i.) All supports are made, and remain, on the same level.

(ii.) The moment of inertia (or the product of the moment of inertia and the coefficient of elasticity) is constant throughout the beam. (See Addendum as to varying *IE*.)

The two following theorems will be taken as proved :—

(*a*) If for any system of forces a force polygon, polar diagram and funicular polygon be constructed, and if then a line be drawn parallel to the line of action of one of the forces, the intercept of the line so drawn between the sides of the funicular polygon (produced if necessary) which meet on the line of action of that force multiplied by the perpendicular distance of the pole from the line in the force polygon representing that force gives the moment of the force about any point on that line.

Where the forces are all vertical this may be more simply stated as follows :—

If the funicular polygon of any system of vertical forces be drawn and a vertical be drawn cutting the two sides of the funicular polygon (produced if necessary) which meet on the line of action of one of the forces, then the intercept (of the vertical line) between these two sides of the funicular polygon multiplied by the polar distance equals the moment of the force about any point on the vertical line so drawn.

(*b*) The elastic line, or true strained form, of a beam is the same as that of a cable whose load diagram is the bending moment diagram of the beam when the cable is also subjected to a horizontal pull equal to the product of the moment of inertia of the beam section and the coefficient of elasticity of its material (*i.e.*, to *IE*). This is known as Mohr's Theorem. The funicular polygon of the bending moment diagram considered as a load diagram when drawn with a pole distance *IE* gives the form of this cable.

§ 8. The fact that the general form of the required diagram for the continuous beam (one span loaded) will be of the type shown in Fig. 4 will be clear from the following considerations :—The upward action of the supports *b* and *c* at each end of the loaded span will cause negative moments at the supports as shown in Fig. 4. The ends *a* and *f* being free, there can be no moments there. The conditions at the other supports can be inferred best by first imagining the supports *D* and *E* removed. The beam will then tend to bend to a form similar to that shown by the broken line in Fig. 6 (*a*). The action of support *D*, which retains the beam line on the same level (according to assumption (.) § 7), would therefore be a downward action and the strained form would then resemble the broken line of Fig. 6 (*b*). Finally, if support *E* be introduced, its action would clearly be an upward pressure in order to keep the beam line at *e* on a level with the other supports. From this it is clear that if one span of a continuous beam only be loaded, the supports forming each end of that span will exert an upward pressure on the beam and the supports beyond will exert pressures alternately downward and upward. A downward acting support is equivalent to a load and causes at the point of its action a positive bending moment, whereas an upward acting support causes a moment of the opposite sign—viz., a negative moment. At the end supports no moments exist since the beam is free to bend to any slope there, but the rule as to alternate upward and downward action still holds good. This shows that the required bending moment diagram will be of the form shown in Fig. 4.

§ 9. The continuous beam bending moment diagram (of Fig. 4) may be regarded as made up of the summation of two other diagrams :—

One.—The diagram for the loading on the span (which may be called the " span " moment diagram) considered as free-ended, ignoring any effect of the supports due to continuity. This will obviously be the same as the diagram in Fig. 1.

Two.—The diagram due to the action of the supports only (the " support " diagram) ignoring the span loading. This will be of the form shown in Fig. 5.

These may be regarded as the component parts of the complete diagram of Fig. 4.

§ 10. It now becomes evident that it is only necessary to find the support moments and the whole diagram can then be drawn, inasmuch as the data of the problem are always sufficient for the construction of the span diagram.

§ 11. Some of the properties of the diagram in Fig. 4 must now be investigated with a view to ascertaining a *modus operandi* that will give by graphical construction the values of the moments at *b* and *c*—B_B and B_C—(*i.e.*, the magnitude of *bt'* and *cu'*), and then from these the values of B_D (*i.e.*, *dw'*) and B_E (*i.e.*, *ex'*). This investigation is made by applying Mohr's theorem (see (*b*) § 7) and will show how the method already enunciated was arrived at and so establish the theoretical basis on which it is founded.

§ 12. Having given the general form of the bending moment diagram (Fig. 4), the next step is to trace the elastic line, or rather what might be termed an " elastic line equivalent," by splitting up the area of the bending moment diagram into smaller component areas and considering the area of each acting as a vertical force through the centre of gravity of the area and drawing a funicular polygon with pole distance *IE* (or

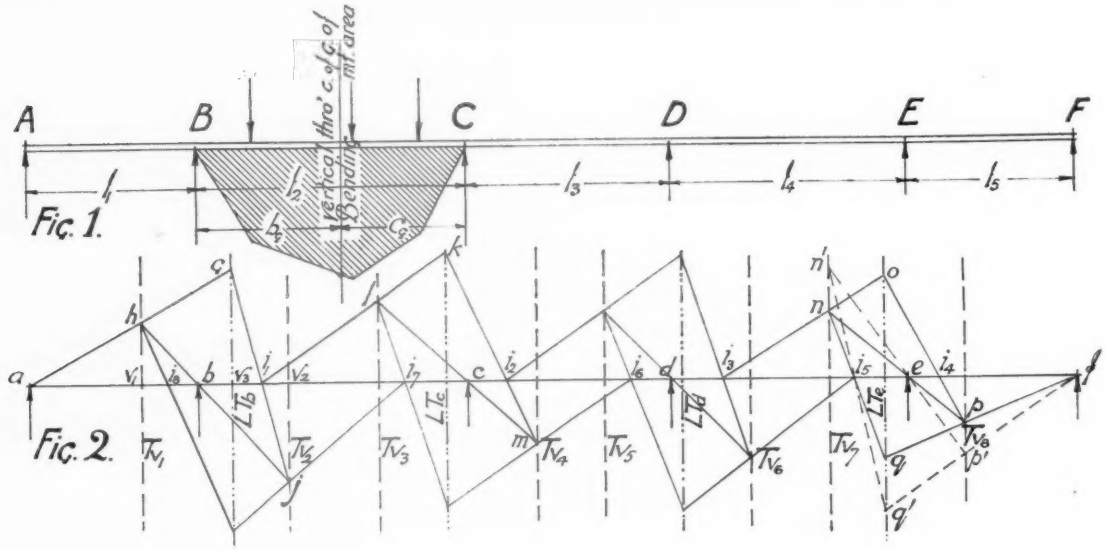
A
B
C
D
E
F
Vertical thro' c. of G. of mt area
Bending
Fig. 1.

Fig. 2.

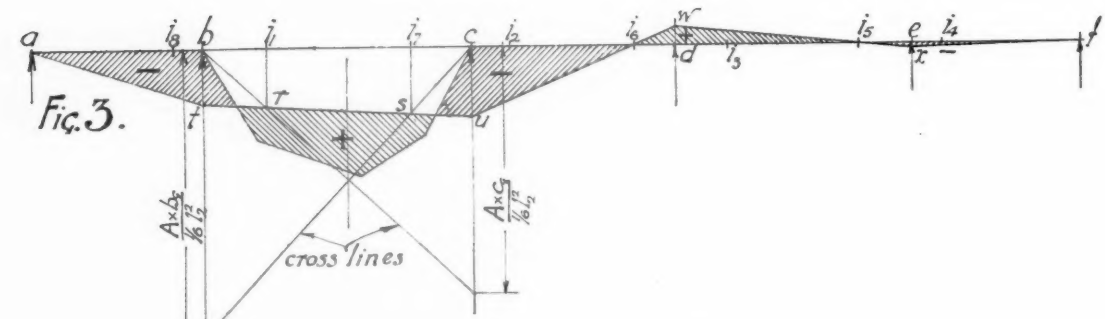
Fig. 3.
cross lines

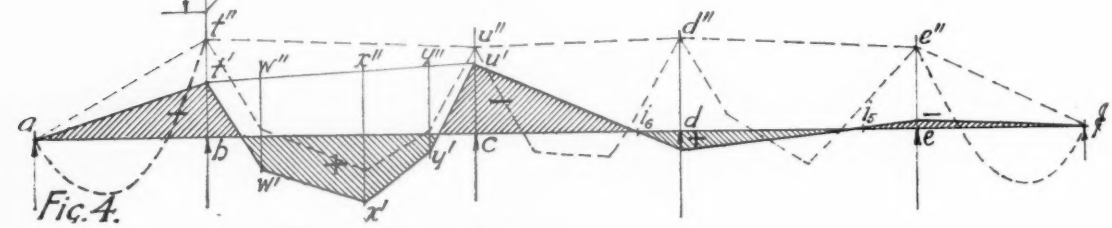
Fig. 4.

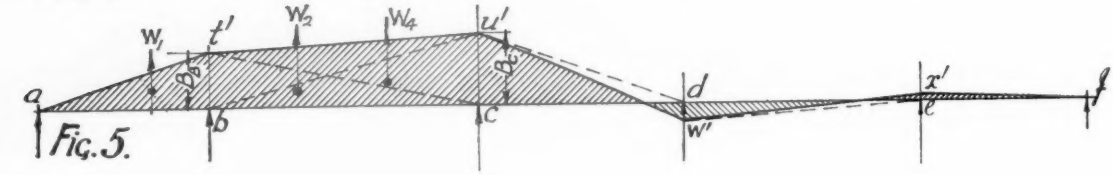
Fig. 5.

$\frac{1}{n}.IE$ for convenience, which would give a representation of the elastic line such that the deflection at each point would be n times the true deflection). As previously stated, the only points that it is necessary to investigate are the support points; and the effect at the supports will be the same if the area of the bending moment diagram in each span is divided up into any convenient areas, positive and negative, and these areas replaced by forces (acting downwards or upwards according to the sign of the area). A funicular polygon of these may then be drawn with a convenient pole distance (representing IE to some scale which it is not necessary for the present purpose to know), and the result will be an equivalent of the elastic line which will be accurate for the support points. That is, the side of the funicular polygon through the support points will indicate truly the slope of the beam at those points.

§ 13. Let the complete bending moment area (as in Fig. 4) be divided up as follows :—

In Fig. 5. Join bu' and ct' and also join $u'd$ and $w'e$.

The bending moment area may then be considered as split up into the undermentioned parts :—

In span A—B : The triangle abt' which will be represented by a negative (upward) force W_1 acting at the centre of gravity of the triangle (*i.e.*, $\frac{1}{3}l_1$ from support B).

In span B—C : (i.) The triangle $bt'c$ to be represented by a negative force W_2 acting at the centre of gravity of the triangle (*i.e.*, $\frac{1}{3}l_2$ from support B).

(ii.) The triangle $cu'b$ equal to negative force W_4 at distance from c equal to $\frac{1}{3}l_2$.

(iii.) Area of " span " diagram (as in Fig. 1) which will be represented by a positive (downward) force W_3 acting at the centre of gravity of the area.

In span C—D : (i.) The triangle $cu'd$ equal to negative force W_5 at distance $\frac{1}{3}l_3$ from c.

(ii.) The triangle $u'w'd$ equal to positive force W_6 at $\frac{1}{3}l_3$ from d.

In span D—E : (i.) The triangle $dw'e$ equal to positive force W_7 at $\frac{1}{3}l_4$ from d.

(ii.) The triangle $w'ex'$ equal to negative force W_8 at $\frac{1}{3}'_4$ from e.

In span E—F : The triangle $ex'f$ equal to negative force W_9 at $\frac{1}{3}l_5$ from e.

It will be seen that the areas composing the " support " moment diagram become forces acting on the " third verticals " ; the " span " moment area (in one span only) becomes a force acting on the centre of gravity of the area.

These forces are represented in Fig. 7, and the intervening spaces numbered for Bow's notation. The corresponding polar, or force, polygon is in Fig. 9, and in Fig. 8 (the heavy line) the funicular polygon, or " elastic line equivalent," in which the lines passing through the support points give the tangents to the elastic line at the supports (the actual tangents of the support slopes will, of course, be $\frac{1}{n}$ of the tangents of these lines, where n is the divisor by which IE was reduced to give H, the pole distance, of Fig. 9).

The sides of the " elastic line equivalent " in Fig. 8 have been numbered to correspond to the rays of the polar polygon to which they are respectively parallel.

§ 14. In Fig. 8. Produce sides 1 and 3 of the " elastic line equivalent " to meet at g, and through g draw the vertical gj cutting the second side in j. Then by theorem (a) § 7, $gj \times H$ is the moment of the force W_1 about any point in the vertical gj and also is the moment of force W_2. Force W_1 is, however, equal to the area of the triangle abt' in Fig. 4 or 5, that is, is equal to $B_B \times \frac{1}{2}l_1$. So also force W_2 is the area of the triangle $bt'c$ (Fig. 5) and is equal to $B_B \times \frac{1}{2}'_2$.

If W_1 be at a distance x, and W_2 at a distance y, from gj, then the moment of $W_1 = B_B \times \frac{1}{2}l_1 \times x$ and the moment of $W_2 = B_B \times \frac{1}{2}l_2 \times y$.

These are each equal to $gj \times H$ and

$$\therefore B_B \times \tfrac{1}{2}l_1 \times x = B_B \times \tfrac{1}{2}l_2 \times y$$

$$\therefore l_1 x = l_2 y.$$

$$\text{or } \frac{x}{y} = \frac{l_2}{l_1} \text{ and } x = \frac{l_2}{l_1}\, y \qquad \text{(i.)}$$

$$\text{But } x+y = \tfrac{1}{3}l_1 + \tfrac{1}{3}l_2 \qquad \text{(ii.)}$$

$$= \tfrac{1}{3}(l_1 + l_2) \qquad \text{(iii.)}$$

Substituting value of x from (i.) in (iii.)

$$y\left(\frac{l_2}{l_1}+1\right) = \tfrac{1}{3}(l_1+l_2)$$

$$\therefore y = \frac{\frac{1}{3}(l_1+l_2)}{\left(\frac{l_2}{l_1}+1\right)} = \frac{\frac{1}{3}l_1(l_1+l_2)}{(l_2+l_1)}$$

$$= \tfrac{1}{3}l_1$$

Then substituting in (ii.) above

$$x = \tfrac{1}{3}l_2$$

The line gj is therefore the " limited third vertical " described in § 3. In the same way it can be shown that sides 4 and 6 of the funicular polygon, or " elastic line equivalent," will meet on LT_c; sides 6 and 8 on LT_d and sides 8 and 10 on LT_e.

§ 15. Produce side 3 to meet support vertical b in h and support vertical c in o; and produce side 4 to meet vertical b in k and vertical c in l (Fig. 8).

By theorem (a) § 7, $bh \times H$ is the moment of W_3 about support B. But W_3 equals, as before, $B_B \times \frac{1}{2}l_2$ and its moment about B is $B_B \times \frac{1}{2}l_2 \times \frac{1}{3}l_2 = B_B \times \frac{1}{6}l^2_2$.

So that $bh \times H = B_B \times \frac{1}{6}l^2_2$.

If H were chosen equal to $\frac{1}{6}l^2_2$, then bh would actually give B_B to the same scale as has been used throughout for bending moments.

Again, by theorem (a), $hk \times H$ equals the moment of force W_3 about support B. Now the magnitude of force W_3 equals A, the area of the free-end bending moment curve as in Fig. 1. And the moment of W_3 about support B equals $hk \times H = A \times b_g$, where b_g, as in Fig. 1, is the distance of the centroid of the bending moment area from B.

Similarly $lo \times H = A \times c_g$.

If H were equal to $\frac{1}{6}l^2_2$

Then hk would equal $\dfrac{A \times b_g}{\frac{1}{6}l^2_2}$

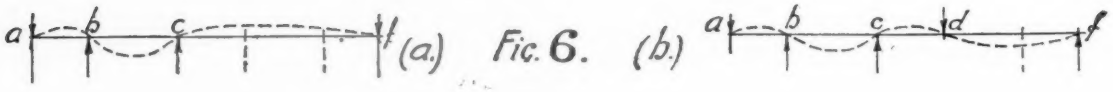

Fig. 6.

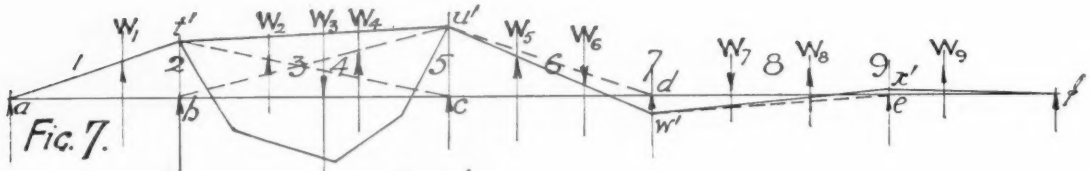

Fig. 7.

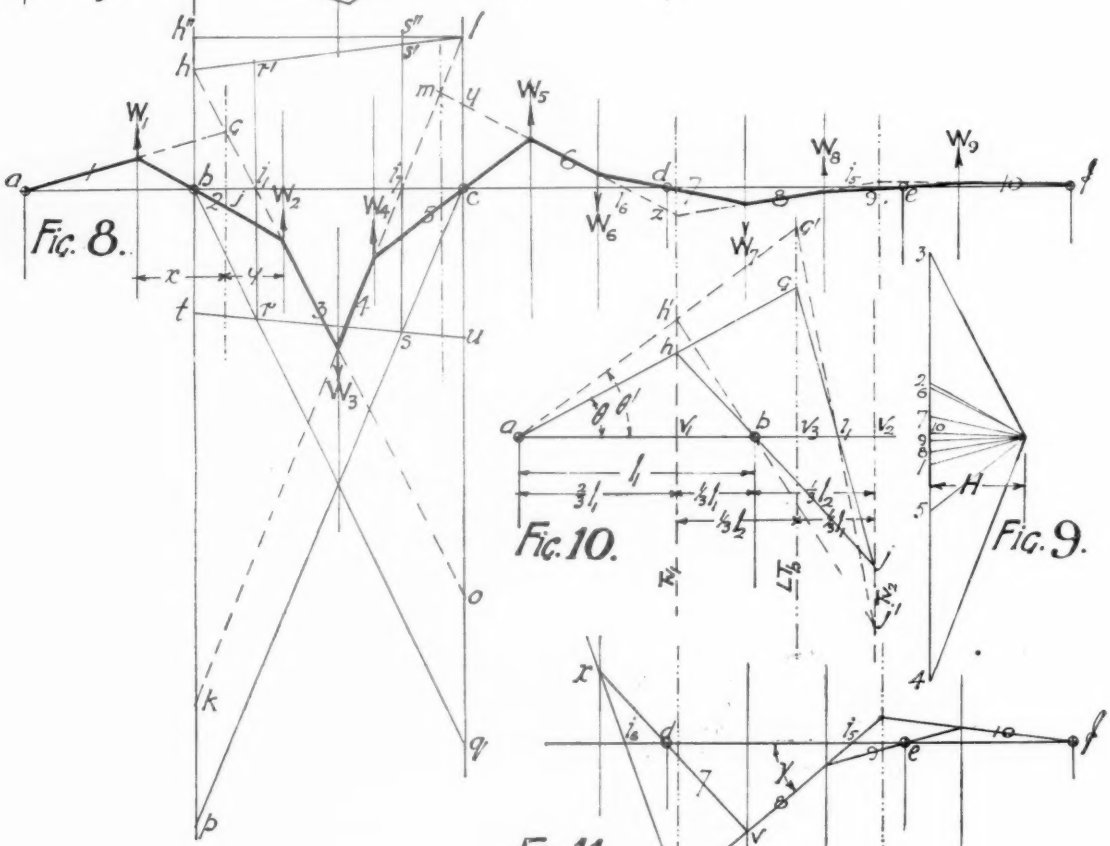

Fig. 8.

Fig. 10.

Fig. 9.

Fig. 11.

And lo would equal $\frac{A \times c_g}{\frac{1}{6}l^2_2}$

If now from b a distance bp be set off vertically downwards equal to hk and below c a distance cq be set off equal to lo and bq and cp joined, and then from i_1 and i_7 verticals be drawn to meet these cross lines in r and s, then rs produced to meet the support verticals in t and u will give bt equal to bh and cu equal to cl, which may be proved as follows :—

From l draw a horizontal line lh'' to support vertical b and produce si_7 to meet lh in s' and lh'' in s''.

The triangles lhk and $ls'i_7$ are similar.

$$\therefore \frac{s'i_7}{hk}=\frac{ls'}{lh} \qquad \text{(i.)}$$

The triangles $ls''s'$ and $lh''h$ are similar.

$$\therefore \frac{ls'}{lh}=\frac{ls''}{lh''} \qquad \text{(ii.)}$$

$\therefore$ From (i.) and (ii.)

$$\frac{s'i_7}{hk}=\frac{ls''}{lh''}=\frac{ci_7}{cb} \qquad \text{(iii.)}$$

The triangles ci_7s and cbp are similar.

$$\therefore \frac{i_7s}{bp}=\frac{ci_7}{cb} \qquad \text{(iv.)}$$

From (iii.) and (iv.)

$$\frac{i_7s}{bp}=\frac{s'i_7}{hk} \qquad \text{(v.)}$$

But $bp=hk$

$$\therefore i_7s=s'i_7.$$

Similarly i_1r may be shown equal to i_1r'.

Therefore the quadrilateral rsi_7i_1 equals in all respects the quadrilateral $r's'i_7i_1$.

Whence it follows that the quadrilateral $tucb$ equals the quadrilateral $hlcb$ in all respects.

$\therefore bt=bh$ and $cu=cl$

§ 16. If H had been equal to $\frac{1}{6}l^2_2$ then hk would have equalled $\frac{Ab_g}{\frac{1}{6}l^2_2}$ and lo would have equalled $\frac{Ac_g}{\frac{1}{6}l^2_2}$ and hb and lc would actually, without further adjustment, represent B_B and B_C respectively to the bending moment scale as already explained. If, therefore, bp and cq had been made equal respectively to $\frac{Ab_g}{\frac{1}{6}l^2_2}$ and $\frac{Ac_g}{\frac{1}{6}l^2_2}$ as in Fig. 3, then bt and cu would respectively be B_B and B_C.

It remains now to show the true position of points i_1 and i_7 in order that the method described above (§ 1 to § 6) may be justified as far as concerns the finding of B_B and B_C; but first of all a parenthetical paragraph with regard to the pole distance H must be introduced.

§ 17. The polar distance, H, really represents in Mohr's theorem the quantity IE; but as the object of the present construction is not to find the elastic line, or to calculate deflections, but only to find the support moments, it is not necessary to calculate IE; the pole distance, H, may be arbitrarily chosen of any convenient length, though to some scale which it is not necessary to know this quantity does stand for the IE of Mohr's theorem.

The cross lines drawn as already explained will, as a matter of fact, be based on an assumed value of H which is different for every span (unless where two or more spans are of equal length), inasmuch as H will be $\frac{1}{6}l^2$, where l is the length of the span whose cross lines are being drawn—each span in turn. This does not affect the fact that in each case what is arrived at (as at hb or bt and lc or cu) is the value of the support moment (for the loading on the span under consideration) to the bending moment scale in use throughout for the free-end diagrams notwithstanding the varying lengths of the underlying pole distance H.

§ 18. To resume now the connection with § 16 and investigate the properties of the "i" points :—

Consider the part of the funicular polygon around support b. This is re-drawn enlarged in Fig. 10. The triangle gjh has two of its angles (h and j) on third verticals, one angle (g) on a limited third vertical, while one side (hj) passes through the support point b and one side (gh) produced passes through a. These are fixed and essential conditions whatever had been the loading on Span 2 or the pole distance H.

Denoting the angle gab by θ.

Then $gv_3=av_3 \tan \theta$.

$$=(\tfrac{2}{3}l_1+\tfrac{1}{3}l_2) \tan \theta.$$

Also $hv_1=\frac{2}{3}l_1 \tan \theta$.

The triangles hv_1b and jv_2b are similar.

$$\therefore \frac{jv_2}{v_2b}=\frac{hv_1}{v_1b}$$

That is, $jv_2=\frac{hv_1}{v_1b}\times v_2b$

$$=\tfrac{2}{3}l_1 \tan \theta \times \frac{\frac{1}{3}l_2}{\frac{1}{3}l_1}$$

$$=\tfrac{2}{3}l_2 \tan \theta.$$

The triangles gv_3i_1 and jv_2i_1 are also similar.

$$\therefore \frac{v_3i_1}{v_2i_1}=\frac{gv_3}{jv_2}$$

$$=\frac{(\frac{2}{3}l_1+\frac{1}{3}l_2) \tan \theta}{\frac{2}{3}l_2 \tan \theta.}$$

$$=\frac{(\frac{2}{3}l_1+\frac{1}{3}l_2)}{\frac{2}{3}l_2}$$

This proves that the position of i_1 with respect to v_3 and v_2 (the limited third vertical and third vertical) is quite independent of the loading on the second span. It is, moreover, quite independent of the angle θ and would be exactly the same if ag assumed the position ag' making its angle of inclination θ'.

Considering now the other end of the beam—spans fe and ed—drawn to an enlarged scale in Fig. 11 with the angles exaggerated for clearness sake, it is evident that proceeding from right to left from end f the point i_5 is fixed in exactly the same way as i_1 has just been shown to be with respect to end a. An application of the same reasoning would give the same position for i_5 in terms of l_5 and l_4 as was found to fix i_1 in terms of l_1 and l_2. Proceeding further to the left from i_5 the position of i_6 is seen to be found by a repetition of

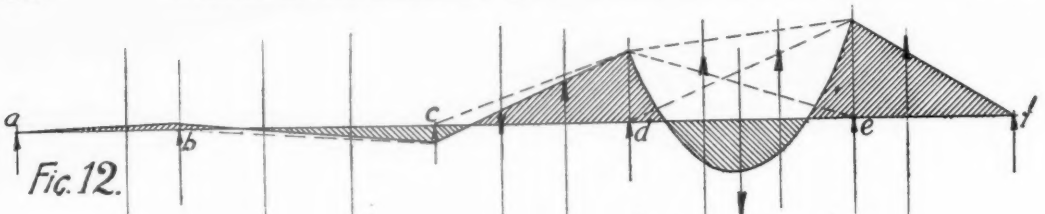

Fig. 12.

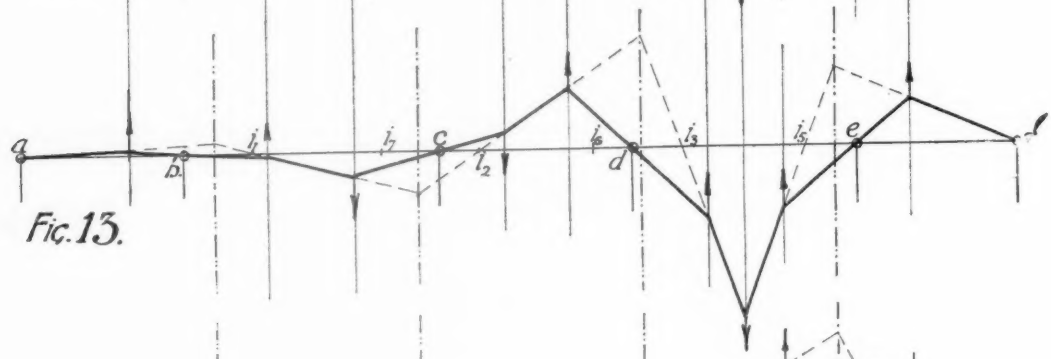

Fig. 13.

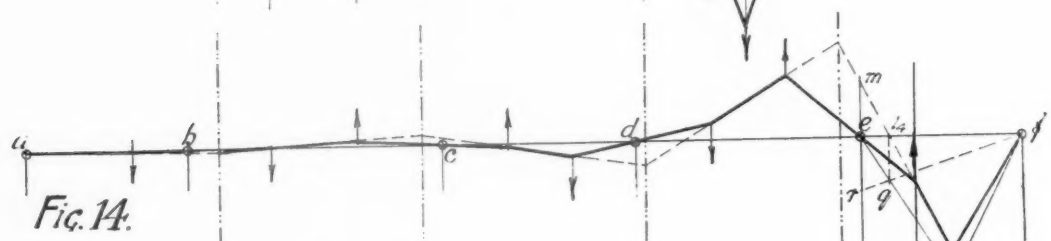

Fig. 14.

Fig. 15.

Fig. 16.

precisely similar conditions—viz., a triangle *wvx* having two angles on thir l verticals, one on a limited third vertical, one side passing through the support point and one side produced passing through a fixed point (in this case i_5). The same reasoning will show that whatever value be given to the angle γ the position of i_6 will be the same and will be a function only of i_6d and l_3, quite independent of any loading. As i_5e is a function of l_5 and l_4, then i_5d will be also a function of l_5 and l_4, and i_6d will also in consequence be dependent only on the relative lengths of the *l*'s.

Returning to Fig. 8 and continuing the process one step further, it will be seen that i_7 is found again from i_6 by the same process and is a fixed point dependent for its position only on the relative lengths of the spans.

If now span 4, (*d*—*e*), were loaded in some way to give a bending moment diagram as shown in Fig. 12, the funicular polygon, or "elastic line equivalent," would then work out as in Fig. 13. By comparison of Figs. 8 and 13 it will be evident that i_1 and i_5 are still in the same positions and can be proved so by an application of the same reasoning used above to prove i_1 was a fixed point independent of any loading arrangements. Moreover, these points remain in their positions whether the span in which they are situated is loaded or unloaded.

In Fig. 14 the effect of loading an end span is shown, and this again bears out the same conclusion—viz.:

"That in each span (except end spans with a free end) there are two '*i*' points depending for their position only on the relative lengths of the span, and further that these points occupy the same positions whether the spans in which they occur be loaded or unloaded."

The method by which these points are seen to be fixed in unloaded spans, as in Figs. 11, 8 and 13, is the simplest way of finding them and is obviously the same as shown in Fig. 2 and described in § 4. When beginning from right to left (Fig. 2) at point *f*, the line *fp* might have been drawn at any angle to meet LT_e in *q*, but by drawing it through *p* (already fixed) the line *pn* through the support point is made use of again instead of having to draw another as would have been the case if *p* had been at *p'*.

§ 19. The peculiar properties of the "*i*" points in the case of a loaded span will be seen from paragraphs 15 and 16; but in the enunciation of the general method (§§ 1 to 6) it will be seen that in the case of an unloaded span they are (or rather one in each span is) treated as inflection points where the bending moment is zero. That this is justified may be seen in referring again to Figs. 7 and 8. In Fig. 8 $cy \times H$ is the moment of force W_5 about support *C*, and $dz \times H$ is the moment of force W_6 about support *D* (Th. (*a*) § 7). As the lever arms of these forces are the same, viz.: $\frac{1}{3}l_3$, the moments are proportional to the forces—*i.e.*, *cy* and *dz* are proportional to W_5 and W_6. In Fig. 7 *cu'* and *dw'* are also proportional to W_5 and W_6; and therefore the zero point in Fig. 7 coincides with i_6 in Fig. 8 and similarly in other spans, which proves that "*i*" points are "inflection" points in unloaded spans.

§ 20. In considering loading on an end span as in Fig. 14 it becomes evident that some slight modification of § 15 as to cross lines becomes necessary for application to a loaded end span. In Fig. 14 the last, and last but one, sides of the funicular polygon are produced to meet the support verticals in *m*, *n* and *o*. If $H = \frac{1}{6}l^2_5$, then *mn* and *fo* are respectively equal to $\frac{Ae_E}{\frac{1}{6}l^2_5}$ and $\frac{Af_E}{\frac{1}{6}l^2_5}$ as before. In practical work *ep* is set down equal to $\frac{Ae_E}{\frac{1}{6}l^2_5}$ and *fo* equal to $\frac{Af_E}{\frac{1}{6}l^2_5}$ and *fp* and *eo* are joined to form the cross lines. Through i_4 a vertical is drawn to meet the cross line in *q*, and *fq* produced to meet the support vertical in *r* cuts off *er* equal to B_E to the general bending moment scale. This is due to the fact that the end of the beam, if free-ended, is really the second "*i*" point of the end span.

§ 21. If the end of the beam were built in or held so as to be fixed horizontally in direction, a bending moment is called into being over the end supports in such a way that the bending moment diagram assumes the form shown in Fig. 15 (*a*) when the end span is unloaded and the form of 15 (*b*) when it is loaded. This gives two forces in the end spans to form the "elastic line equivalent" in place of the one of Fig. 7; and they each act on a third vertical. The effect of fixity at the ends is to maintain the end sides of the "elastic line equivalent" horizontal and the first inflection point (and the last) will come on the third vertical instead of at the end as shown in Figs. 16 (*a*), (*b*). In proceeding to find further "*i*" points the first inclined line is drawn therefore from the first third vertical intersection with beam line—not from the end of the beam, as in the case of a free-ended beam.

For loading on the end span in a fixed-ended beam § 15 as to "*i*" points and cross lines applies in all respects, points i_4 and *i*—the last third vertical—being the "*i*" points.

This completes the demonstration of the theoretical basis of the method enunciated in general terms in §§ 1 to 6.

§ 22. Where the load is uniformly distributed the construction of the cross lines becomes simplified. The free-end (or "span") bending moment curve is of parabolic form; and if B_M is the maximum ordinate (in the centre of the span), then the area of the curve is $B_M \times \frac{2}{3}l$ and the distance of the centroid from either support is $\frac{1}{2}l$. In that case the general expressions $\frac{Ab_E}{\frac{1}{6}l^2}$ and $\frac{Ac_E}{\frac{1}{6}l^2}$ become $\frac{(B_M \times \frac{2}{3}l)\frac{1}{2}l}{\frac{1}{6}l^2} = 2B_M$.

The cross lines will therefore intersect one another on the span centre vertical at a distance B_M from the beam line, so that it is only necessary to set up the central bending moment ordinate of the free-end curve on the span centre vertical and join the point so found

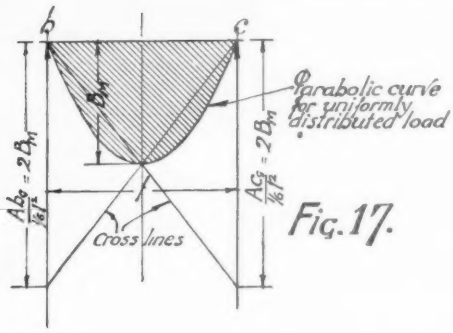

Fig. 17.

to each support point which gives the required cross lines (see Fig. 17).

JOHN H. MARKHAM.

September, 1917.

ADDENDUM.

VARYING MOMENT OF INERTIA.

Although it has not been necessary in the whole of the process already described to assign any value to the quantity IE, yet if the assumption had not been maintained that this quantity remained constant throughout the beam, the horizontal pull in Mohr's imaginary cable, and hence the pole distance by which the "elastic line equivalent" was drawn, would have varied from point to point—a state of affairs that is not covered by the methods elaborated above. As a matter of fact it will generally happen, especially in beams of reinforced concrete, that the moment of inertia will vary considerably in different parts even of the same span; but the effects of this on the results obtained by assuming it constant are not very considerable.

If greater accuracy were desired having regard to the variability of the moment of inertia, it would be necessary to perform the construction as detailed above on the assumption of a constant moment of inertia, then assign tentative values to the moments of inertia at points along the beam and recommence the construction after adjusting the bending moment curves as follows :—

Choose any convenient point in the beam, such as the centre of one of the spans or the position of the maximum bending moment ordinate in one of the spans. If I_c is the value tentatively assigned to the moment of inertia at that point and I_1, I_2, I_3, I_4, etc., represent the moments of inertia assigned to points 1, 2, 3, 4, etc., and if B_1, B_2, B_3, B_4, etc., are the ordinates of the original span bending moment diagrams at the same points, then new span curves must be drawn in which B_1 is replaced by an ordinate equal to

$$B_1 \times \frac{I_c}{I_1};\ B_2 \text{ by } B_2 \times \frac{I_c}{I_2};\ B_3 \text{ by } B_3 \times \frac{I_c}{I_3} \text{ etc.}$$

The new span curves that result from this adjustment are then to be used in reconstructing the continuous beam bending moment diagram with a constant value of IE (the value of I being the I_c already referred to).

In this way allowance may be made for a variation in the "flexural rigidity" (as the quantity IE is called) in cases where such accuracy seems called for. When this is done the beam may be designed and final values of the moments of inertia will replace the tentative ones.

In reinforced concrete beams it will be necessary to calculate the moment of inertia about the centre of the depth of the beam section and to take into account the concrete both in tension and compression.

J. H. M.

CONTROLLED BUILDING MATERIALS

THE Science Committee find that there is a good deal of uncertainty in the minds of many architects with regard to the control or restriction imposed in the use of building materials owing to the fact that the Ministry of Munitions and other authorities have issued regulations which change from time to time to meet the varying national demands.

The Science Committee have had under consideration the question of using other materials in substitution for those which are now either not available or restricted in use by the various authorities. As a preliminary to the further consideration of the subject the following report is presented on behalf of the Science Committee as an indication of the present difficulties, in the hope that suggestions for restricted materials may be made by members of the Institute :

1. *Generally.*—No building work, interpreted in its widest sense, may be undertaken if the total contemplated expenditure exceeds £500, or is even of a less amount than £500 and involves the use of structural steel, unless a licence be first obtained from the Secretary (L), Ministry of National Service, S.W.1. A proper application form is provided, which should be carefully and fully filled up. The issue of a licence, however, does not ensure that the various restricted or controlled materials mentioned below will be allowed; for these further application must be made to the Controller, the Priority Department of the Ministry of Munitions, 1, Caxton Street, Westminster, S.W.1. Architects with buildings to design or alter should eliminate everything but the absolutely essential, bearing the following restrictions in mind.

2. *Timber.*—All foreign woods are subject to import licences, and for most descriptions these licences are obtainable only when the Controller of Timber can be shown that the importation is necessary for work of national importance.

The Controller of Timber further controls the use of the leading imported woods, namely, softwoods, teak, American walnut, and lignum-vitæ.

Home-grown woods (both hard and soft) are at present free from control as to use, but further developments of control in this direction are by no means unlikely.

The important woods, both home-grown and imported, are subject to maximum prices. As economy in the use of timber of all descriptions is of the highest importance, substitutes should be used as much as possible; for example, the use of wood for ground floors should be avoided.

Stringency is likely to increase rather than decrease and it is therefore desirable to consult the Timber Supply Department frequently as to the actual position.

All applications for permits and information should be addressed to the Controller of Timber Supplies, Board of Trade, Caxton House, Tothill Street, S.W.1.

3. *Steel and Iron.*—Steel, both of mild and shell-discard quality, in the form of joists, channels, plates, angles, etc., is controlled by the Ministry of Munitions, and a Priority Permit, to be obtained from the Priority Department of the Ministry, 1, Caxton Street, is necessary before such material can be released by merchants or stock-holders.

Expanded metal and other steel fabrics, galvanised and corrugated iron are similarly under control.

Patent glazing, having the bars made of mild steel with lead flashings, is not permitted.

Steel casements are practically prohibited unless of shell-discard quality and obtainable from stock.

Malleable iron is also prohibited.

Cast and wrought iron are at present uncontrolled, and can be used as substitutes for some of the above materials, but in practice it is often found that the Ministry of Munitions permit is required before stock-holders will release such material.

4. *Lead.*—1 cwt. of sheet lead or lead piping or lead bends, and not more than 28 lbs. of solder, can be used without the necessity of obtaining a permit for the purpose of necessary repairs or renewal requiring immediate execution and for which no other metal can be substituted.

No lead in the form of sheet or pipe is available for ordinary building operations, such as for flats, gutters, sinks, sanitary work, etc., except in very urgent cases.

Asphalte or asphalted felt can be frequently made use of as a substitute.

5. *Copper and Brass.*—These metals are controlled as severely as lead.

6. *Floorings.*—Most jointless floorings are practically prohibited, as they contain magnesite.

7. *Asbestos Sheets.*—Most forms of asbestos sheeting have now been commandeered by the War Office, but for extremely urgent work it is possible to obtain the release of small quantities. The use of asphalte and asphalted felt for temporary purposes fill up the gap to a certain extent.

8. *Lead Paint.*—This is prohibited without a permit excepting from existing stocks which contain not more than 3 per cent. metallic lead.

9. *Uncontrolled Materials.*—The following are some of those upon which no restriction is at present placed:

Bricks, tiles, slates, sand, cement, lime and stone. Home-grown timber, cast iron, wrought iron, asphalte, certain wood block flooring, floor tiles, mosaic, glass, wall-papers, distempers.

Gravel, hard core and granite are partially restricted by the Road Stone Control Committee.

Note.—It is intended to revise the above report from time to time as may be necessary, in view of the issue of further restrictions and prohibitions.

A. O. Collard [*F.*],
Digby L. Solomon [*A.*],
Hon. Secretaries, Science Standing Committee.

FRANCIS BOND, *Hon. Associate.*

1852–1918.

The death of Mr. Francis Bond deprives all lovers of architecture of a most enlightened teacher. He had done more perhaps than any Englishman in recent years to arouse the consciousness of his fellow-countrymen to the existence in their midst of the priceless heritage they possess in the treasures of Gothic art, and next to persuade them to understand, to appreciate and to study. Countless people, both in this country and in English-speaking nations beyond the seas, owe to Mr. Bond's books and lectures the beginning of a lifelong interest in architecture, and they will join with us in sorrow that his voice is still and his industrious pen has been laid down.

Mr. Bond passed in 1868 from King Edward's Grammar School at Louth—a fine photograph of the spire at Louth always hung in his study—to New College, Oxford, but on being elected Scholar, migrated almost immediately to Lincoln. He adopted teaching as a profession, and was for a few years classical master at Christ's Hospital; afterwards he joined the staff at the Cowper Street Foundation School, London, and closed his career in the scholastic world as headmaster of the Hull and East Riding College, which he raised to a very flourishing condition.

In 1893—in mid-career—he boldly took the step of changing his profession and joined the Oxford University Extension Delegacy as lecturer—first giving a course of twelve lectures on Physical Geography and another series upon Commercial Geography. He then commenced his notable courses—each of six lectures—upon "Gothic Architecture," "Norman and Gothic Architecture," "The Mediæval Architecture of England," "Renaissance Architecture." He retired in 1914 and received on retirement the high compliment only paid by the Delegacy to those who, like Mr. Arthur Acland, Professor Poulton, Sir H. Llewellyn Smith, Vice-Chancellor Sadler, etc., have rendered specially distinguished service to the Extension work of the University, of being made Honorary Member of the Staff. It was the high

quality rather than the great quantity of his work that was recognised by the University. He was an admirable teacher and especially good as a guide on architectural excursions.

His first book, *English Cathedrals Illustrated*, was published in 1899 by George Newnes, Ltd., afterwards to be thoroughly revised and in part re-written and republished in 1912 as *The Cathedrals of England and Wales* (B. T. Batsford). His great book for architectural students, *Gothic Architecture in England*, an analysis of the origin and development of English church architecture from the Norman Conquest to the dissolution of the monasteries, was published (Batsford) in 1906, and has a wide sale all over the world. In 1908 he launched through the Oxford University Press the series of books on Church Art in England, with *Screens and Galleries in English Churches*, followed by *Fonts and Font Covers in English Churches*. In 1909 his fine book on *Westminster Abbey* was published and also the *Visitors' Guide to Westminster Abbey*, one of the best practical guide-books to a church ever written. Next year, *Wood Carving in English Churches* appeared, and in 1913 he published his two magnificently-illustrated volumes under the title of *An Introduction to English Church Architecture* (Oxford University Press).

This was his crowning work. It was written not so much for the professional student as for the great body of readers who nowadays are interested in mediæval architecture and wish to obtain some general knowledge of it. It had a large sale in America, but the great upheaval caused by the war has perhaps suspended its influence on the English reader. It was his wish to do for the monastic churches what he had done for the cathedral and parochial churches, and he had collected a large number of monographs and MS. notes for the purpose. But he was not able, and had not time, to undertake the work.

Dedications and Patron Saints of English Churches also appeared in 1913, and in 1916 a book, to which he gave peculiar care and investigation, on *The Chancel of English Churches*. During the same period between 1908 and 1917 he edited several books by various authors issued in the same series of books on Church Art.

Mr. Bond was elected Hon. Associate of the Institute in 1896, and was for many years a member of the Literature Standing Committee. He was a generous contributor to its TRANSACTIONS, either by Papers at Sessional Meetings or by articles and reviews in the Institute JOURNAL. Among his more notable Papers are the following: "On the Comparative Value of Documentary and Architectural Evidence in Establishing the Chronology of the English Cathedrals" (JOURNAL, Vol. VI. 1889, p. 17); "Classification of Romanesque Architecture" (JOURNAL, Vol. VIII. 1901, p. 269); "Notes on the Architectural History of Lincoln Minster" (JOURNAL, Vol. XVIII. 1911, pp. 33, 84, 300, 425).

A man of great independence of judgment, Mr. Bond could always give reasons for the faith that was in him. Some people found him dogmatic, but he could write in 1914 candidly in a preface: "The writer is not ashamed to admit that he has had to unlearn much; no honest student can continue to work at his subject year after year without having the good opinion of his previous work considerably lowered, so much there is that ought to have been said but was omitted, so much that ought to have been said otherwise; so much, alas! that ought not to have been said at all." Personally, the writer can speak only of his entire kindness; he was always ready to answer a question, to advise one on knotty points, to put one on the right track. He had a large correspondence all over the kingdom and was most sensible of the kindness of the many photographers of architectural detail who added by their pictures so largely to the usefulness of his books.

He lived for many years at Waddon, near Croydon, in a house on Duppas Hill, with a large terraced garden that he rejoiced in planning, in planting and in attending. He was a great gardener on certain lines and perhaps was to be seen at his best when on Sunday afternoons he entertained his friends at Waddon, where, surrounded by his family and his roses, he walked and talked among his flowers, plucking great sheafs of blossoms for a lady, or leading a little child by the hand to the spot where the strawberries glowed or the raspberries were thickest.

PRESCOTT ROW.

The Rev. G. W. Saunders, of Martock Vicarage, Somerset, writes:—

I first met Mr. Francis Bond at Wells. He was giving a course of lectures on architecture, and I was a student at the Theological College, and spending much spare time in taking a series of photographs of the capitals in the cathedral. He was very interested in the work, and from that time to the day of his death we kept up a correspondence on archæological matters, in which I was the learner and he the teacher. He was always ready to place his knowledge at the disposal of any who needed it, and his books were written chiefly for that large public who were beginning to take an interest in our ancient churches. His great purpose was to make that interest more intelligent, and to base it on historical lines. With this in view he broke away from the traditional style theory and wrote of architecture as a connected whole, with a continuous history, and applied to it the evolutionary theory. He speaks of his "Gothic Architecture in England" as "an attempt not to classify, but to work out processes of development." In all his works he tries to show that for every change there was a reason, and to view the subject through the eyes of the mediæval master masons and to realise their difficulties and work out again their problems. His conclusions may not always be correct ones, but he has succeeded in making architecture a live art, interesting and

practical. Under his guidance we enter an ancient building with a new motif—to learn about it, and not merely to date it, and to answer such questions as, Why, Wherefore, Whence, and How ?

In 1905 he could write with regard to architecture : " There never was a time of such blackness of indifference as to the master art of architecture. Nowadays it is outside the precincts of culture. Educated people know little and care less about it. Their ignorance is naked and unashamed. . . . At the older universities tens of thousands of pounds are expended every year to encourage the study of literature, mathematics, history and science ; not a single penny on architecture."

He complained that at Oxford and Cambridge there was neither a professorship, lectureship, scholarship, or fellowship in English mediæval architecture. Excavation work was unsupported, and the science was badly represented in our museums and our Royal Academy. If things are better to-day it is largely due to his enthusiasm and his writings.

He was always ready to welcome criticism and to receive help and advice, and was equally ready to give it. A keen photographer himself, he had a large number of friends who placed their work at his disposal, and it is due to them that his works are so abundantly illustrated. To help him in this way meant to be helped yourself.

Towards the close of his life he became anxious about the disposal of his large library. His wish was that his books should get into the hands of those who would value them. Only a few weeks before his death he asked the writer to select any books he wanted from a long list, and he did the same to others. It was all in keeping with the wish of his life that the interest he had aroused might be continued, and that others might be enabled to carry on his work.—G. W. Saunders.

CORRESPONDENCE.

Demobilisation and Reconstruction.

H.M.S. "Glorious," c/o G.P.O., 25 Jan., 1918.

To the Editor, Journal R.I.B.A.,—

Sir,—Criticism of authority is always an ungrateful task, but perusal of the philosophical debates of the R.I.B.A. leaves me with a doubt as to the use of the Institute to the younger men. Practically every member fit and of military age joined up in the first year of war. What help is the Institute going to give to these young men in restarting their businesses ? Is it not rather making sure that those who had achieved small offices of their own shall return to the ranks of draughtsmen ?

Take this Cottage Competition. Who can enter for it ? Certainly those at home only. If the object of the competition is achieved and the cottages built, it will not be the men on service who will build them. Yet two or three of these blocks of cottages would be enough for many a man to start an office with ; the Institute is making certain that they shall not get them. I am lucky enough to have a few postponed jobs to restart with myself, so I write without personal feeling. A large proportion of us will, of course, not come back, but it is going to be hard on those that do. Their service pay will have ceased, and as very few have private means they will have to become draughtsmen again in the offices of the older men. This may seem to be taking a narrow and personal view of the matter, but it is not really so.

The future of architecture is in the hands of the younger men, and the broadening of their views effected by war ought to bring about a Renaissance if they are given their chance. A little thought is worth a lot of scholarship, and we've all been learning to think. Our whole education has always been given up far too much to details of style and technique. We come back from Italy, say, with notebooks full of careful details of Peruzzi's mouldings and very little notion of why his buildings are beautiful, and we produce no great buildings. The note of English architecture of the better sort is scholarly tameness. War is blunting the edge of our worship of detail and making us realise space and mass. The beauty of H.M.S. *Tiger* is not a question of detail ! and for the first time we realise the sky. All honour to the Institute for trying to imbue departmental officials with architectural sense ; but let them remember that the younger men are the men that are going to matter, and start some practical scheme for helping them.—Your obedient servant,

John Coleridge, Lieut. R.N.V.R.,
Licentiate.

It is satisfactory to be able to assure Lieut. Coleridge that the older men left to " carry on " at home are not unmindful of the after-the-war interests of their colleagues who are fighting the country's battles. The matter is being constantly debated by the Architects' War Committee, and the Architects' Reorganisation Committee has many schemes in prospect. The Secretary of the latter, Mr. F. R. Yerbury, has kindly jotted down the following notes of what his Committee is doing, and hopes to do :—

The Architects' Reorganisation Committee, which is composed of representatives of all branches of the profession, together with the Council of the Architectural Association, is dealing with questions affecting the architectural profession after the war. It has many schemes under consideration, and as a result of its work, it hopes to be of particular assistance to architects who are at present serving in the Forces, when they are demobilised.

One suggestion which the Committee is dealing with is the establishment of co-operative offices, which will facilitate the return of young architects to practice. It hopes to make special arrangements for the reservation of Government architectural posts for architects who have been on war service. The Committee has

adopted Mr. Lanchester's proposals for "Social Circles" for young architects. This scheme was fully outlined by a paper read by Mr. Lanchester at the A.A. in November last.

The A.A. has established a bureau for men discharged from the Army, and all questions affecting their return to civil life are dealt with. It has also established a drawing office for providing employment for disabled architect soldiers who are not fit to take up permanent work in an architect's office. It is intended from time to time to publish details of further schemes and the Committee will welcome suggestions from any members of the profession, particularly those on service.

The important thing to emphasise, is that an organisation is in existence to assist any member of the profession who encounters difficulties of any kind on account of his war service.—ED.

After the War: Some Crying Needs.

To the Editor, JOURNAL R.I.B.A.,—

DEAR SIR,—I see in one of the daily papers that it is now proposed to push ahead with the reconstruction schemes for various districts in this country so that the work of building may be started as soon as peace is declared. In the face of the present great need for our national energies in other directions, I should have been inclined to doubt the accuracy of this statement were it not for the fact that I had ascertained by enquiry a little while back that an architectural housing competition was actually being held.

There are undoubtedly several channels into which any superfluous architectural energy which is running to waste at the present moment might be usefully directed. There is, for instance, the crying need for the remodelling of Building By-laws, both urban and rural, to allow of the scientific use of modern materials and inventions, and also to enable decent cottages to be built in agricultural districts at reasonable rates; there is the question of the restrictions on leasehold property, the possibility of so modifying our plumbing by-laws that bathrooms and so forth may be provided in blocks of dwellings on the same generous scale as obtains on the other side of the Atlantic, and other points in the laws which affect building.

The end of the war is still hidden in the mists of the future, and we cannot yet say what will be the conditions under which we shall have to live when peace comes. It seems, at any rate, likely that the general system of life will be considerably altered. National Kitchens may be instituted in connection with all artisans' dwellings in large towns, and possibly a more scientific cultivation of the land may lead to great changes in our village life as well. We have no precedents to guide us and our prophets of the last four years have proved themselves sorry bunglers at their business. To prepare for a future which can be foreseen is wise, but premature preparation for a future which cannot yet be reckoned with is a waste of our resources.

There is another consideration, which, however, I would not press if the call for these schemes seemed urgent. The point is this: at the present time a large proportion of architects are engaged on other duties, either in this country or overseas, which prevent them from taking any part in these schemes. A great number of these men have acquired an intimate knowledge of the needs and views of the artisan class which should be most valuable in the preparation of housing schemes, and by pushing ahead with these projects at the present time we lose all the advantage of their freshly acquired knowledge.

There is also the question of the fairness of the policy of holding architectural competitions from which the greater number of architects who were on the list at the outbreak of war are debarred from competing. At the present moment there are two, and only two, great and urgent claims on our services. The one is to provide men and munitions to crush the enemy, and the other is to raise foodstuffs to feed the people.

Until we are convinced that all that is possible has been done in these respects, we cannot consider ourselves free to turn to other pursuits, and until the future becomes far clearer than it is now it would surely be wiser to divert any spare architectural energy to clearing the ground by getting into force a more rational system of building regulations rather than to embark on any actual project of building which is only too likely to prove premature and abortive.—Yours faithfully,

ARTHUR BARTLETT, Lieut. R.E.S.

The Future of Architecture.

243 *St. Vincent Street, Glasgow.*

To the Editor, JOURNAL R.I.B.A.,—

SIR,—That my following remarks may be understood more readily while they are being read, let it be clearly mentioned beforehand that there are two conflicting matters in architecture. One is that of not accepting any kind of remuneration beyond the ordinary commission for architectural services; which is a very elastic matter that has been stretched in many directions till its boundaries are not easily ascertainable. The other is quite the reverse; it is the position of the naval architect, who is able freely to take up anything, without letting anyone know what his profits are, and without any sentimental considerations.

It is not assumed that the above statements are absolutely accurate. It is admitted that there could be much hair-splitting over details which are of no consequence to my arguments. Of late, it is becoming realised that there is a modern tendency to undermine the position of architects by architectural tradesmen and others by employing architectural draughtsmen and by supplying drawings with accompanying estimates of contemplated works, there being no statement of charge for the drawings. It is beginning to be noticed that there are contractors who are getting

a command of the situation, and are becoming business princes, while a number of architects are "going to the wall." And there are no means by which this could be interrupted, because, for some mysterious reason, architects would condemn contracting, as practised by naval architects, as objectionable by architects, and want the latter to withdraw from the profession. But why? Where would be the iniquity?

It is possible that there are many architects of good business capacity whose strongest instinct is to amass money, and who could and would be able to undertake and execute some of the large plain works in a better way than the ordinary contractor does. Why should not those who so desire become contracting architects after the methods of the naval architects? This might become a very great advantage to the other architects, by preserving the other architectural work to men who love their art above everything, and do their work as artists, and could supply their designs in their own personal handiwork.

Is there any real objection to an architect not only making his design but also supplying a valid estimate, and thus obtaining for himself all the reasonable profits that pertain thereto? In doing so he would cut off the possible discredit of the original nominal estimate being greatly exceeded by the ultimate cost. It is just here that architects are losing so much; here that the contractor places himself on top; here, in this way, that so many architects get left on the scrap heap; here that business men have no faith in architects. Whereas, if an architect, after the manner of a naval architect, gave a plain businesslike estimate of the whole, the business employer would probably much prefer a trained architectural contractor, and we should begin to know what it is to become a great, reliable, important profession, respected for our business capacity. Does it not appear that architects should at once consider these questions, not sentimentally, but as a plain matter of business, for it is a great question, requiring a careful study? It might involve having a new class of architects in our Institute, who might have a distinguishing title, such as "contracting architects."

HORATIO K. BROMHEAD [*F.*].

The Comacines.

Briantcroft, Milford-on-Sea, Hants,
1st March, 1918.

To the Editor, JOURNAL, R.I.B.A.,—

SIR,—Sir Thomas Jackson has honoured me with his criticism, for which I am obliged to him; but I wish he could have seen my further notes on the Comacines before writing his letter to you of the 28th January, as I believe he would then have, at least, modified his views. Apart from that, however, I cannot imagine how Sir Thomas Jackson draws from my book such conclusions as he does. I fail to find that I suggest anywhere that the Comacines were "the centre of a system of craftsmanship to which we owe all the monuments of the Middle Ages." What I do say is, "they spread their influence over all Western Europe, and even to our own shores."

Nor can I find where I assert that the Comacines were "the inheritors of the traditions of architecture from the building of Solomon's Temple downwards." My contention is that they derived their art principally from Rome, and I think every allusion I make to any connection between them and Solomon's Temple, which I hold to have been, in its erection, largely under Hittite influence, refers to symbolic traditions relating to the Temple which influenced their architecture in some few details of ornament only.

What my summary says on this point is: "In Rome developed Collegia of Artificers, and in early Christian days these had traditions of King Solomon."

As to the myth which makes the Temple at Jerusalem "the seed of future architecture," I can only say I never heard of it until now.

My making havoc of proper names I do not understand, unless Sir Thomas Jackson refers to four such in each of which unfortunately two vowels got transposed and which in reading the proofs I overlooked. I detect a slip of the same nature in Sir Thomas Jackson's letter.

The legend of Sesinius is, in one version, such as given by Sir Thomas, and I refer to it in my book as contained in Voragine's *Golden Legend*, but that is not the masonic tradition.

W. RAVENSCROFT [*F.*].

The Victoria Embankment and a War Memorial.

The *British Architect* for February has a fuller descriptive account of the proposal put forward by Mr. Edward W. Hudson [*A.*] for completing the Embankment with statuary as part of a scheme for a National Memorial of the Great War, briefly set out in a letter to the JOURNAL of 28th August, 1916. Two illustrations are given reproduced from original designs, showing statuary groups on the pedestals along the river wall from Blackfriars to Westminster. There are over fifty of various sizes available, placed next the bridges, and at water steps midway. Mr. Hudson proposes that the subjects for the larger groups should be incidents of the greatest prominence in the conflict; on the land side of the boulevard statues of British and principal Allied generals, admirals, &c., to be placed at intervals just inside the railings of the public gardens. The new Charing Cross bridge to play an important part, having a triumphal arch at each end with quadriga on modern lines on the top. Between these at each pier suitable statuary and bas-reliefs. In the Plaza, which seems generally expected to be in front of the entrance to the bridge, a high monumental tower with open sides to be the chief feature. A colossal figure of "Retribution" on the lower stage and "Victory" above; round the base bas-reliefs and tablets. The whole should form a "Place de la Concorde" in London. By means of lifts a magnificent view of the River and the cities of London and Westminster would be obtainable from the top. This part of the scheme would have to be postponed, but the work along the Embankment could be started as soon as peace is declared. Whatever scheme be adopted, the present, in the proposer's view, is the time to decide and prepare, as urged by the late M. Rodin.

9 CONDUIT STREET, LONDON, W., 16*th March*, 1918.

CHRONICLE.

The Associateship: Special War Regulations.

On the recommendation of the Board of Architectural Education the Council have granted the following temporary concessions to Students R.I.B.A. and others seeking to qualify for Associateship R.I.B.A.:

A. SPECIAL WAR EXEMPTION.

A Student of the R.I.B.A. who has attained the age of at least 21 years, and

(1) has passed the Intermediate Examination of the R.I.B.A., or has passed through a full course at any of the Schools recognised by the R.I.B.A. and has received a certificate which gives exemption from that examination, and

(2) has served in some full-time employment in His Majesty's Forces during the war for a period of *not less than two years*; or has relinquished his commission or been discharged from service after less than that period owing to wounds or other disability arising from or in such service,

shall be held to be qualified for candidature as Associate R.I.B.A., as if he had already passed the Final Examination.

A Student R.I.B.A. must make an application on an official form, accompanied by a remittance of four guineas, which will be returned should his application be refused.

He must also send with his application particulars of his service in His Majesty's Forces, and a certificate from a member of the Royal Institute, or other architect of recognised position, that the Student is a proper person to be admitted to the Associateship.

N.B.—This exemption does not apply to candidates who under the previous concession of November, 1914, have been registered as Students without having either passed the Intermediate Examination or obtained the certificate mentioned under A (1).

B. SPECIAL WAR EXAMINATION.

This examination will be open for three years after the declaration of peace to candidates who have attained the age of at least 21 years and are not eligible for, or desirous of availing themselves of, the Special War Exemption, and

Have served in some full-time employment in His Majesty's Forces during the war for a period of *not less than two years*, or have relinquished their commissions or been discharged from service after less than that period owing to wounds or other disability arising from or in such service.

The examination will be held by the R.I.B.A. twice a year in the months of June and December, or as may be determined from time to time and announced in the official publications of the Royal Institute.

Candidates desirous of entering for this examination and qualifying for candidature as Associate R.I.B.A. must apply on an official form to be obtained from the Institute.

This form must be accompanied by:

(1) A remittance of six guineas, which will be returned should the application be refused.

(2) Particulars of service in His Majesty's Forces.

(3) A certificate from a member of the Royal Institute, or other architect of recognised position, that the applicant is a proper person to be admitted to this examination.

He must also send either with his application form, or before, two Testimonies of Study (Problems in Design) or one Testimony of Study and one Thesis.

The Thesis must be of a practical character, as described under the heading in the KALENDAR, p. 418, "Science as Applied to Building."

The subject selected for the Thesis is to be notified for the approval of the Board two months before the date of the examination, and the Thesis itself is to be submitted four weeks before that date.

If the Testimonies of Study have not previously been submitted to and approved by the Board they must be sent in at least four weeks before the date of the examination for the Board's approval.

All Testimonies of Study submitted for this Special War Examination must be drawn and coloured as working drawings, with, as far as is possible, all construction shown.

The conditions regulating the character of the Thesis and the designs submitted as Testimonies of Study will be insisted upon in view of the omission of the papers on construction, materials, hygiene, etc., from this examination.

Subject to the above conditions the designs may be of

(1) Problems set by the Board.

(2) Subjects set in a recognised school.

(3) Subjects set in the Royal Academy School, provided that the same are approved and initialled by the Visitor.

Candidates who have been awarded the Soane Medallion or the Tite Prize, or who have received a Certificate of Honourable Mention in either of the Competitions, may submit in place of the aforesaid Testimonies of Study their Soane or Tite Designs, and receive marks for same.

The Examination will consist of:

A Design for a building of moderate dimensions, or

a portion of a more important edifice, to be made from particulars given. The drawings to comprise plans, elevations and sections generally to a scale of ⅛ inch to the foot, details of construction and hygiene to a large scale, with a sketch perspective. The subject will be communicated in general terms to the Candidate some days before the examination.

The Examination will extend over four days and there will be subsequently an Oral Examination on the Design and its construction and the Testimonies of Study, including the Thesis, if any.

The attention of candidates is called to the fact that at the Oral Examination they must be prepared to show good knowledge of materials and of construction, as well as of hygiene (as applied to buildings) and of the general practice of an architect.

The Board of Architectural Education reserve the right to refuse to a candidate who fails in this Special War Examination permission to enter for it a second time.

The general conditions published in the KALENDAR relating to essays, carriage of drawings, entrance fee, etc., apply to this Examination.

The London Society's Development Plan of Greater London.

Members will be glad to have in the JOURNAL Sir Aston Webb's interesting account of the work the London Society are doing in connection with the future development and improvement of London. The occasion was a lecture delivered by Sir Aston before the London Society in the rooms of the Royal Society of Arts on the 1st March.

A development plan (said the lecturer) had been drawn up of Greater London based on the 6-inch Ordnance sheet, brought up to date, showing in detail the road improvements proposed by the Traffic Branch of the Board of Trade, together with the Society's own proposals, adding to them suggestions not only in regard to roads, but also parks, parkways and waterside reservations, open spaces, and other improvements. A committee was formed consisting of Professor Adshead, Messrs. Arthur Crow, W. R. Davidge, H. V. Lanchester, H. J. Leaning and D. Barclay Niven, with Mr. A. E. Richardson as hon. secretary. Those gentlemen worked with great enthusiasm, got together a staff of capable draughtsmen, with Mr. Ernest Herbert at their head, and after two years' strenuous work produced, he believed, for the first time, a map showing a complete scheme for the improvement and development of Greater London. The map measured some 15 feet square and covered some 600 square miles, and had cost over £1,000. The late Edward Stanford generously undertook the reproduction of the map, and since his death the firm were continuing it. On the conclusion of peace it was intended that the plan should be exhibted as the Society s war contribution towards the better ordered development of Greater London in the future. The schemes shown were not merely dreams and ideals—though he hoped those were not absent—but they were the considered proposals of practical men, some of whom had visited all the localities treated. Many of the schemes had long been recognised by a Government Department as urgent, and had been generally agreed to by the local authorities in conference. Among the suggestions were two large additional parks for the North-West and South-East. To balance Epping Forest on the North-East a great park and reservation was suggested at Stanmore for the North-West; and to balance Bushey and Richmond Parks and Wimbledon Common on the South-West, the acquisition of the beautiful Addington Park and Shirley Woods on the South-East was suggested. In the South-East was also a park at Bexley bordering on the river Cray and lying to the South-East of Woolwich, which would provide recreation for the future industrial development of the district between Woolwich and Dartford. In addition to those important public parks, waterside reservations were suggested, and parkways to link up, as far as possible, the present open spaces. One such course on the West started at Stanmore, took in Harrow Weald Common, passing between Harrow and Pinner down to Hayes, and then following the line of the Colne till it reached the Thames at Isleworth. Another parkway nearly parallel to the last was suggested from the Brent reservoir, and following the line of the Brent past Hendon, Neasden, and so on, to the Thames at Brentford and Kew. Another on the East side followed the Roding through Chipping Ongar and Buckhurst Hill, Woodford, Wanstead, Ilford, to the Thames at Barking. Another still further East was from Romford through Rainham to the Thames. There was another to the South-West of London through Mitcham to Wandsworth on the Wandle, and one on the extreme South-West following the river Mole to Molesey. The Society suggested that the money for these schemes should be obtained by a Park Commission, as had been done in many places in America, with power to levy a small rate on houses overlooking or benefiting from these open spaces. Another suggested improvement was the embanking of the south side of the Thames, a problem which practically included also the treatment of the south side itself. The suggestion was to reclaim the mud banks along the convex shore from Lambeth to the Borough, an average width of some 166 feet, and the formation of an embankment. It was suggested that from the new County Hall to Southwark Bridge there should be a continuous embankment 100 feet wide with a limited introduction of the lagoon lock principle, which might leave the present riverside properties with their present water frontages practically unaltered. East of Southwark Bridge it was thought the width could be reduced to 60 feet roadway, and that some of the warehouses could be taken over the road to the river, producing an effect like the Amsterdam quays. The ascertained cost of construction, £80 to £100 per foot run for the road embankment, would be far more than covered by the value of the reclaimed land. Some such treatment as that suggested would, while giving splendour and dignity to the upper reaches of the river, preserve some of the picturesqueness of the lower reach.

House Planning: The Housewife's Point of View.

A women's sub-committee of the Advisory Council has been appointed by the Minister of Reconstruction to collect information and to give advice on house plans from the point of view of the housewife. The duties with which they have been entrusted are thus defined: "To examine specimen houses and to advise on house plans received from the Architects' Committee; and to report on such questions as internal fittings, position of doors and windows, size and number of rooms, gardens, communal arrangements, and the arrangement of new districts in so far as it may affect the well-being of homes and the convenience of housewives."

Building Licences.

The authority to make orders regulating or restricting the carrying on of building and construction work under Defence of the Realm Regulation 8E has been transferred by Order in Council from the Minister of Munitions to the Minister of National Service. All applications for licences under Order XIV. of 14th July 1916 should in future be addressed to the Secretary (L), Ministry of National Service, S.W.1.

Sir John Soane's Museum.

The Curator desires it to be known that on application to him special facilities are given to students of the Museum, and that a new students' room on the ground floor has been allotted for the purposes of architectural sketching and drawing from the Museum's unique collection of originals and casts from the antique. A series of 14 post-card views of the House and Museum have been prepared and may be obtained at the Museum at the price of 1s. The cards, which are excellent photographic reproductions and very creditably printed, make an exceedingly interesting set.

MINUTES.

At a Special General Meeting held Monday, 4th March, at 4 p.m.—Present: Mr. Henry T. Hare, *President*, in the Chair; 51 Fellows (including 15 members of the Council), 5 Associates (including 2 members of the Council), and a few visitors—the President having announced that the meeting was summoned in accordance with the By-laws to elect the Royal Gold Medallist for the current year, thereupon moved, Mr. E. Guy Dawber, *Hon. Secretary*, seconded, and it was

RESOLVED, unanimously, that subject to His Majesty's gracious sanction the Royal Gold Medal for the promotion of Architecture be presented this year to Mr. Ernest Newton, A.R.A., in recognition of the merit of his executed work.

The Special General Meeting then terminated.

At a Business General Meeting held Monday, 4th March, following the Special Meeting above-mentioned, and similarly constituted, the Minutes of the meeting held 4th February 1918 were taken as read and signed as correct.

The Hon. Secretary announced the decease of Sir John Wolfe Barry, *Hon. Associate*, elected in 1877, and Francis Bond, *Hon. Associate*, elected in 1896, and it was Resolved that the regrets of the Institute for the loss of these distinguished members be entered on the Minutes, and that a message of the Institute's sympathy and condolence be forwarded to their near relatives.

The decease was also announced of Frederick Montague Gratton, elected Associate in 1881, Fellow in 1893, and placed on the list of Retired Fellows in 1912; Lieut.-Colonel George Arthur Hamilton Dickson, M.V.O., till lately Diocesan Surveyor of Pretoria, South Africa, elected Associate in 1888 and Fellow in 1915; George Scott Miles, *Licentiate*, and John Clarkson, elected Associate in 1869, and Fellow in 1889.

The following candidates for membership were elected by show of hands under By-law 10:

As FELLOWS (4).

GREENSLADE: SIDNEY KYFFIN (*Pugin Student, Grissell Medallist, Godwin Bursar, Associate*).
HARRISON: EDWARD LEWIS (*Licentiate*).
JONES: GERALD E. (*Licentiate*).
STEDMAN: ARTHUR J. (*Licentiate*).

As ASSOCIATE.

CAMERON: KENNETH, 2nd Lieut., R.E.

As HON. ASSOCIATE.

LESLIE: FRANCIS SEYMOUR, Colonel R.E., retired.

The President announced that in order to save labour and expense the Council proposed, subject to the sanction of the Privy Council, not to hold the Annual Elections this year. Whereupon, on the motion of the President, seconded by Mr. E. Guy Dawber, it was

RESOLVED, unanimously, That in accordance with the provisions of Clause 33 of the Charter application be made to the Privy Council to sanction the suspension of the By-laws governing the annual election of the Council, the Standing Committees, and the Hon. Auditors so that the Council, the Standing Committees, and the Hon. Auditors elected in June, 1917, shall remain in office until the 30th June, 1919, provided always that the Allied Societies and the Architectural Association shall be represented on the Council by their Presidents in accordance with the By-laws.

Mr. Walter G. Bell, F.R.A.S., having read a Paper on THE REBUILDING OF LONDON AFTER THE GREAT FIRE, a discussion ensued, and on the motion of Mr. Philip Norman, LL.D., F.S.A., seconded by Professor Beresford Pite *F.*], a vote of thanks was passed by acclamation to the author.

The meeting separated at 6 p.m.

OBITUARY.

James Bruce, of Newcastle-on-Tyne, whose death was recently announced, had been a Fellow of the Institute since 1907. He was also a member of the Northern Architectural Association for a long time, and for some years acted as their honorary librarian. Until a few years ago he was in partnership with the late Mr. H. G. Badenoch, under the style of Badenoch and Bruce, and they were responsible for a great deal of work in the district. Mr. Bruce had travelled abroad considerably. He possessed a unique and wide knowledge of architectural books, and his services were much sought after and readily given to architectural students.

NOTICES.

A Special General Meeting will be held Monday, 25th March, 1918, at 5 p.m., for the purpose of confirming the Resolution relating to the suspension of By-laws passed at the Business General Meeting of the 4th March, and set out in the Minutes of that meeting, above printed.

Informal Conference, 17th April, at 5 p.m.

RELATIONS OF ARCHITECTURE AND ENGINEERING.

Professor W. R. LETHABY will open the discussion.

Principal Contents of this Issue.